



# **Workshop on Application of Electron Beam (EB) Technology to Wastewater and Biosolids Treatment**

May 10 & May 11<sup>th</sup>

Fermi National Accelerator Lab

**Dr. Charlie Cooper**

**Fermi National Accelerator Lab**

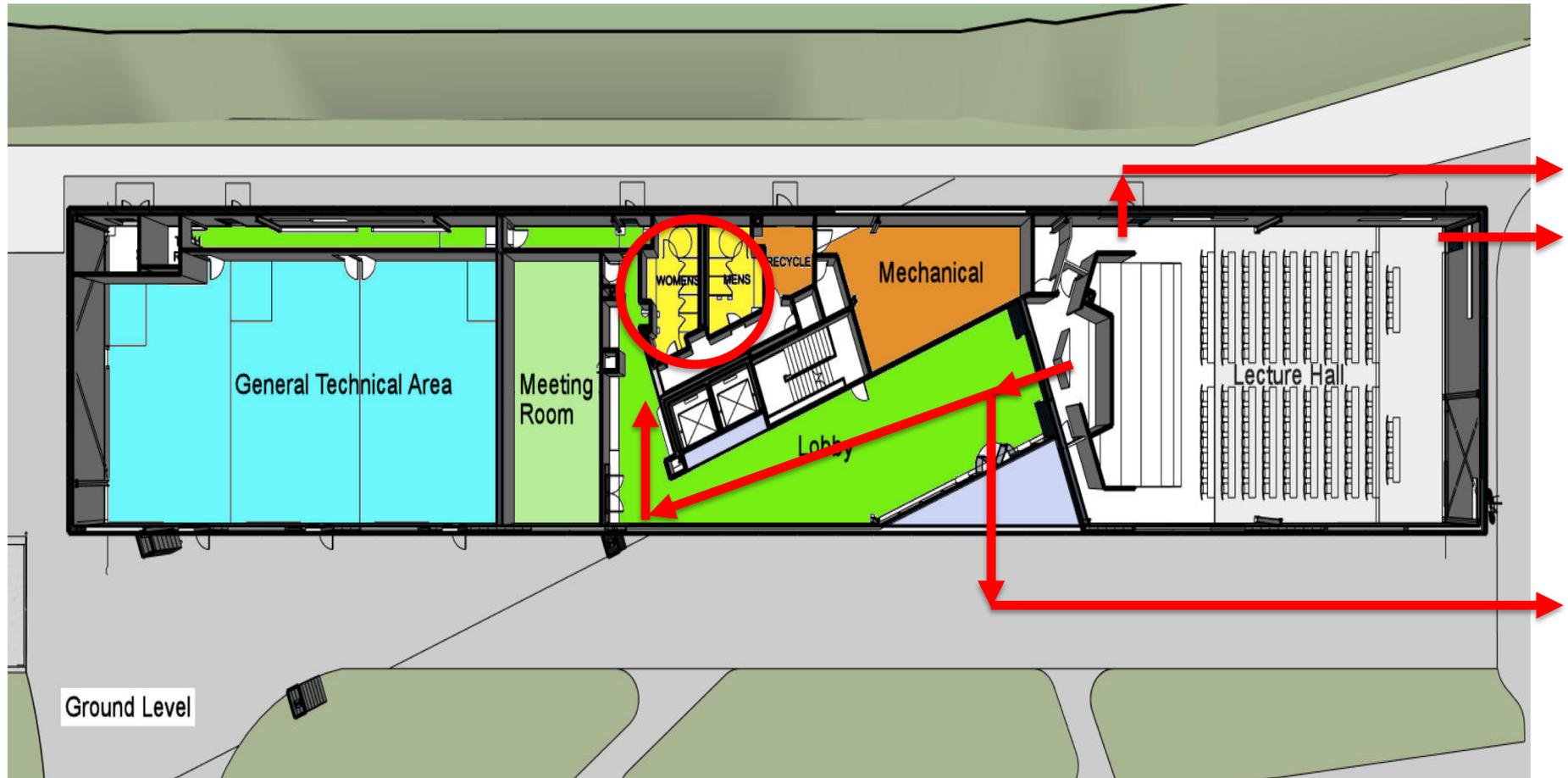
**Dr. Fredrick Bloetscher**

**Dr. Daniel Meeroff**

**Florida Atlantic University**

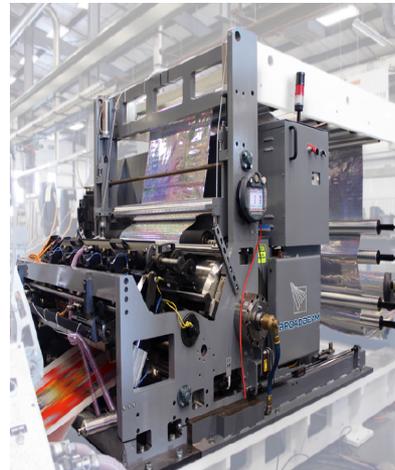
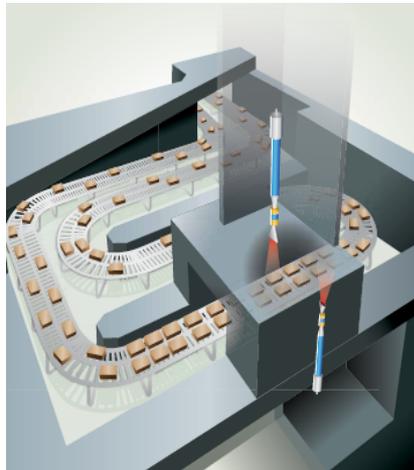
# Fire/Tornado Safety

- Tornado – Bathrooms      Fire – Parking Lot



# Background – Electron Beam Accelerators

- At Fermilab particle accelerators are a fundamental tool used in discovery science
- In industry over 30,000 accelerators operating worldwide, electron beam accelerators have over \$2 B/yr in sales, touch more than \$ 500 B/yr in products



# Background – Electron Beam Treatment of Water



- Simultaneously acts on contaminants while generating oxidizing and reducing radicals from the water
- Removal of toxic chemicals not removed in conventional domestic water treatment
  - Pharmaceuticals
  - Agricultural run off
  - Fuel additives (MTBE)
  - PCBs
  - PFAS/PFOA - perfluorinated compounds
- Reduction in pathogens
- No toxic residuals (no secondary waste generation)

# Background – NSF Workshop, 2018

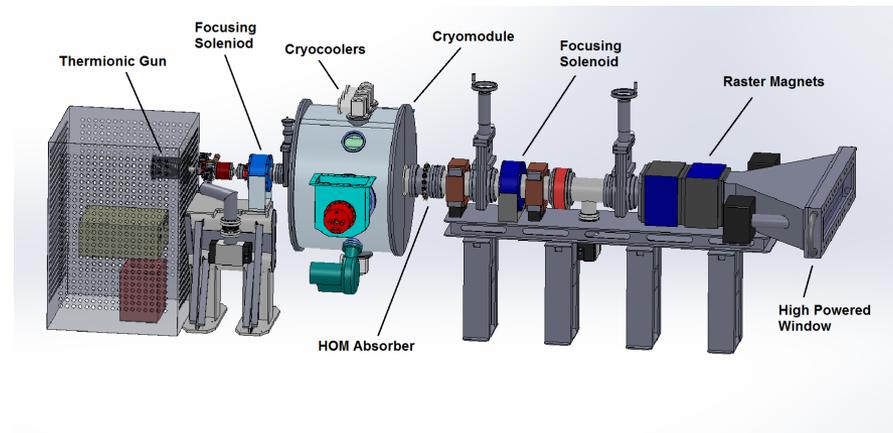
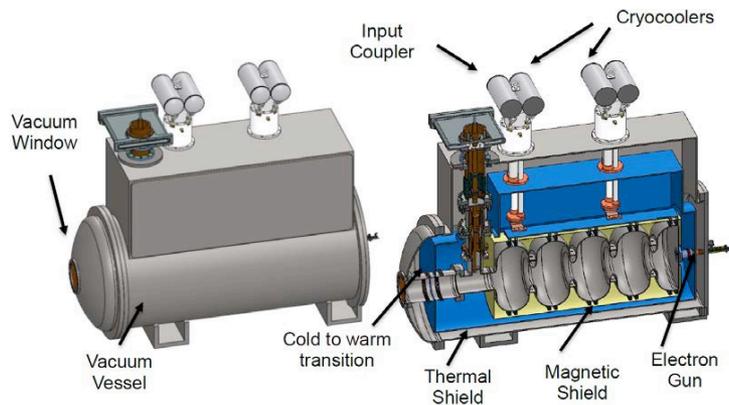
Dr. William (Bill) Cooper  
*Is one of the pioneers of  
electron beam processing  
for water treatment in the  
U.S.*



While a professor at University of California, Irvine he was appointed director of the environmental engineering program in the NSF's Chemical, Bioengineering, Environmental and Transport Systems Division. Bill has since stepped down from the NSF, but directed the funding for this workshop.

# Background – DOE Workshop, 2015

- This workshop is follow up to findings from a DOE Workshop held in 2015 at Argonne Lab in Illinois. That workshop explored research and development opportunities for high-impact applications of accelerator technology to address energy and environmental challenges in a broad sense.
- Funding made available from the DOE Accelerator Stewardship Program as a result of that workshop allowed for design of novel, energy efficient accelerators for water treatment by DOE labs Fermilab and Jefferson Lab.



# Background

The new accelerator designs from the 2015 DOE workshop should allow for cheaper operating costs and could enable new applications. This and increasing concerns over emerging contaminants make it a good time to reevaluate the use of electron beam accelerators for treatment of waste water.

## Purpose:

- Promote use of e-beam technology for wastewater treatment
- Inform water treatment professionals about e-beam technology and opportunities
- Provide feedback to NSF that opens future funding opportunities

# Background, Florida Atlantic University

Florida Atlantic University has a strong water program focused on aquatic toxicity, water quality and water/waste water treatment.

- **Dr. Fredrick Bloetscher**
  - Professor Department of Civil, Environmental and Geomatics Engineering
- **Dr. Daniel Meeroff**
  - Director of the Laboratories for Engineered Environmental Solutions and Associate Chair of the Department of Civil, Environmental & Geomatics Engineering at FAU



# Background, Fermi National Accelerator Lab



Fermi is a National Lab Funded by the Department of Energy

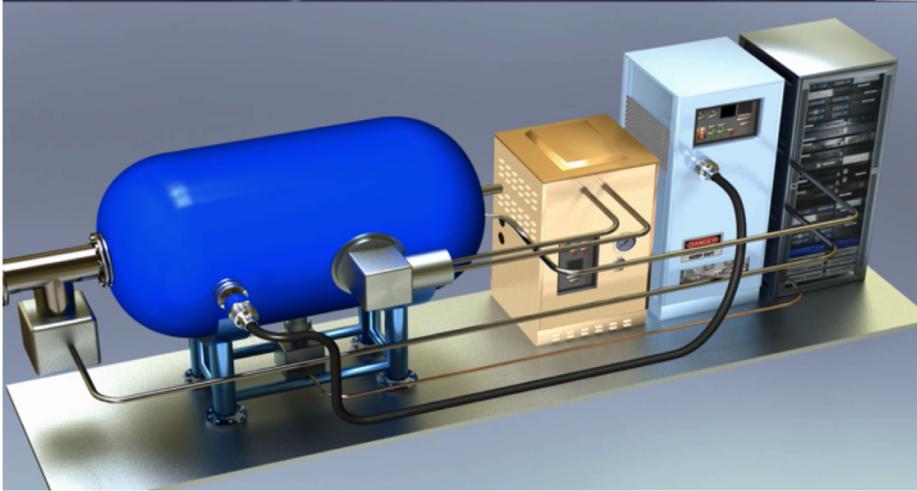
- Base mission of discovery science through high energy physics research
- Fundamental discovery tool at Fermi is the particle accelerator
  - Largest concentration of accelerator experts in the World
  - Expertise in accelerator design, simulation, fabrication, integration and test
  - Unique facilities for design, test and operation of accelerators

# Background, Illinois Accelerator Research Center

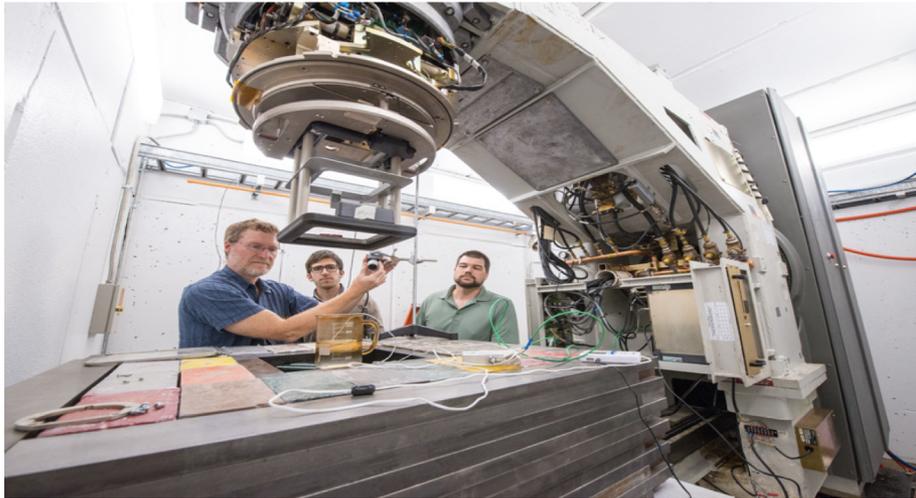


- There have been and will continue to be new technologies developed in the pursuit of basic science. (Accelerators, Detectors, Magnets, Computing)
- IARC is focused on developing accelerator based technologies to the point where they are attractive to industry.
- Through IARC we can leverage Fermi's human capital, facilities and technologies.
- We believe that the technologies we are developing at IARC will enable new fields and demonstrate Fermi's impact, beyond basic discovery science, on the nation's health, security and wealth.
- <http://iarc.fnal.gov/>

# Compact Accelerator Platform Technology



Currently we are integrating multiple new technologies to create a compact, portable, high power, high reliability electron beam platform accelerator.



## **A2D2 Developmental Accelerator.**

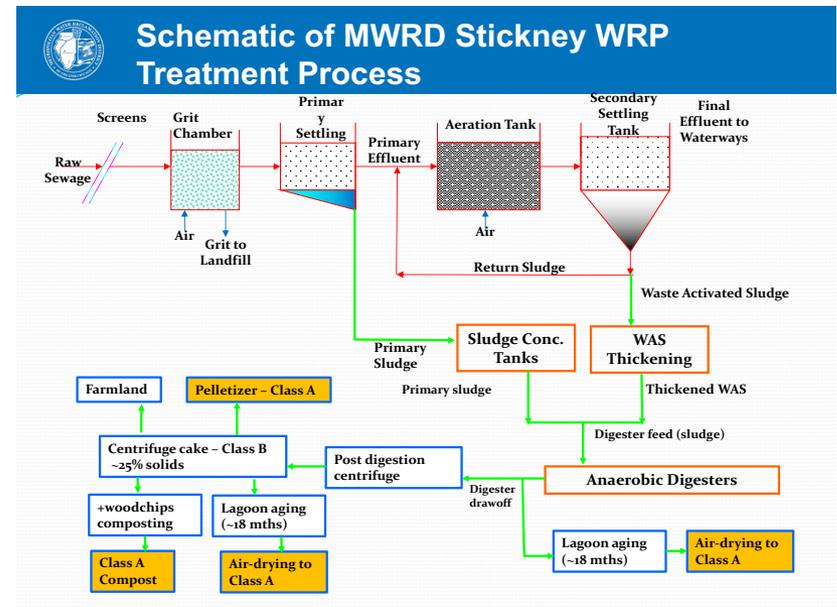
We are concurrently developing applications for this compact accelerator.

# Session 1

## 9:40 – 10:25 Municipal Wastewater Treatment Technologies: Present and Future

Tom Kunetz, Assist Director of Monitor. & Res., MWRD

- Regulatory requirements and emerging contaminants
- Overview of conventional and best available technologies
- Removal efficiency, energy consumption, economics (cost per kgal to treat), public interest (e.g. odors)
- Opportunities for application of e-beam in wastewater treatment



Break

## Session 2

- 10:45-11:30 **Electron Beam Treatment of Wastewater and Biosolids: Current State of the Science**
  - Terri Slifko, MWD of Southern California
  - Suresh Pillai, Texas A&M University
- Removal efficiency for pathogens, organics, nutrients (N and P), pharmaceuticals and personal care products, endocrine disrupting compounds, and emerging contaminants
- Success stories from where E-beam treatment has been used for water/biosolids around the world
- Removal of Per- and Polyfluoroalkyl Substances (PFAS)

# Lunch

- 11:30 – 12:45 **Working Lunch (provided)**
- Dean Amhaus, President and CEO of the Water Council will discuss current issues in industrial waste water as a precursor to session 3.



# Session 3

- 12:45-1:45 **Industrial Wastewater Issues** –  
– Moderated by Dean Amhaus Water Council

Wisconsin Based Cheese and Dairy Ingredient Company



**Covanta**  
North America's Largest Energy-from-Waste Facility Operator



Our plants convert residential trash, industrial by-products, unwanted and outdated inventory, medical and other wastes to steam through a thermal, boiler-driven process. This steam is sold to cities and industrial facilities with whom we partner, or else converted into electricity.

2 May 10, 2018




**US Army Corps of Engineers®**  
Engineer Research and Development Center

Pat Cardiff, Grande Cheese

Karen Bleach, Covanta Env.

Edith Martinez-Guerra

## Milwaukee Metropolitan Sewerage District

**We Protect the Public & Lake Michigan:**

- Convey/Store/Reclaim Wastewater
- Manage Flooding

**We Serve:**

- 1.1 Million Customers
- 28 Municipalities
- 411 Square Miles

**We Have:**

- 2 Water Reclamation Facilities
- 521 MG Tunnel System



Matt Magruder, (MMSD)

## Brewery Wastewater Opportunities

- Nutrients
  - Phosphorus
  - Ammonia
  - Nitrogen
- Source reduction upstream
- Discharge Temperature limits
- Bio solids-odor



Fort Worth wastewater treatment

Joan Giuliani, MillerCoors



# Session 4

## 1:45 – 2:30 Moderated Panel with Audience Participation: What are the Barriers to E-Beam Implementation?

– Moderated by Tom Waite, Florida Institute of Technology

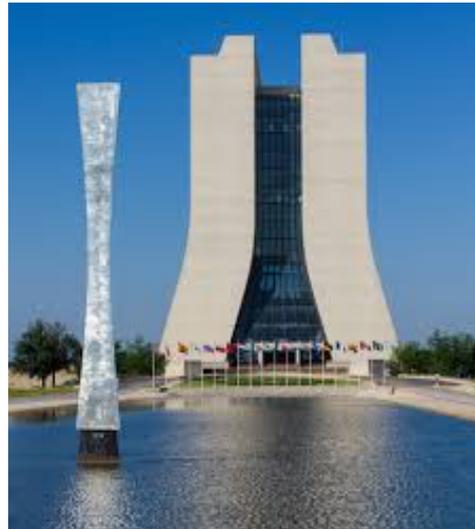
- Sandip Chattopadhyay, NRS Research Center, EPA
- Barry Liner, Water Science & Engineering Center for The Water Environment Federation.
- Gigi Ciovati, Jefferson Lab
- Sekou Sidime, ComEd

## Break

# Fermilab Tour

**3:00 to 5:00** - tour tickets with a printed scheduled is in your name badge holder.

- IARC – Heavy Assembly Building and Developmental Accelerator
- Industrial Center Building
- Cryomodule Test Facility
- Wilson Hall



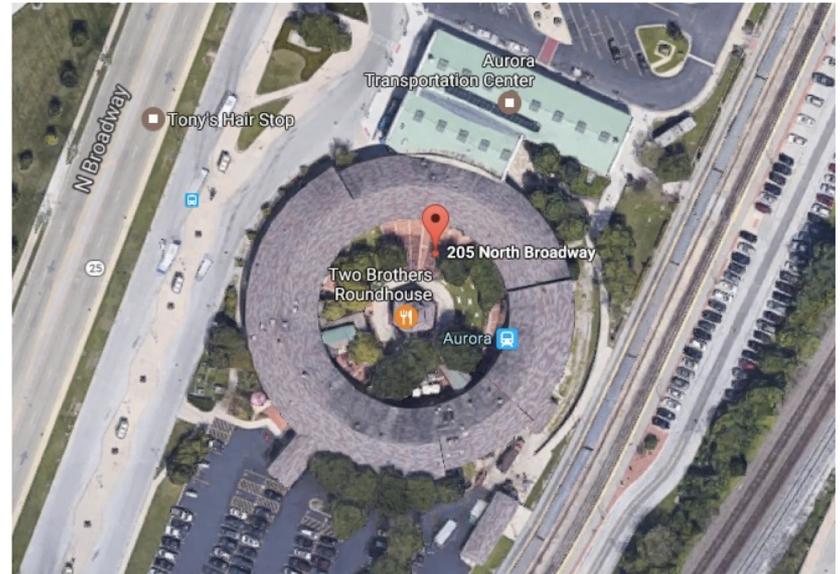
# Networking Gathering

6:00 – 7:00

Two Brothers Round House

205 N Broadway, Aurora, IL 60505

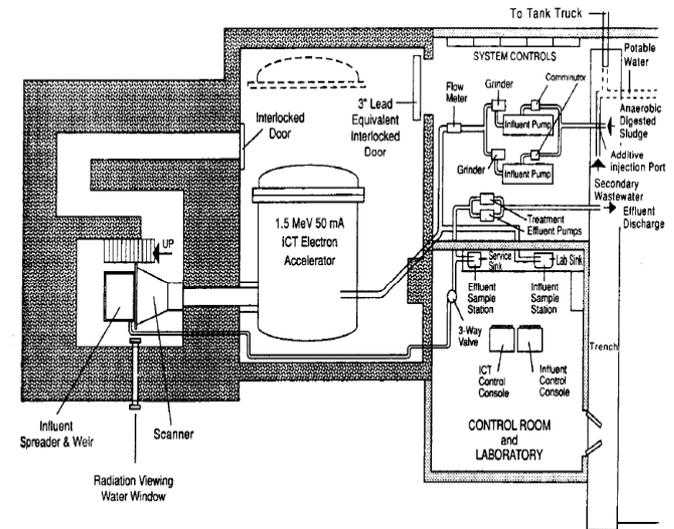
[Twobrothersbrewing.com](http://Twobrothersbrewing.com)



# Session 5

Day 2 - May 11th, 2018 Friday

- 8:30 – 9:00 **Session 5 – Presentation: Miami-Dade County Experience with E-Beam**  
– Robert Fergen, Miami-Dade County



# Session 6

- 9:00 – 9:30 **Economics of Wastewater/Biosolids Treatment by E-Beam**
  - Dan Meeroff, Florida Atlantic University
  - Cost breakdown (capex, opex)
  - Reliability, redundancy, backup power, pretreatment, downstream impacts, mixing regime, shielding, other design considerations
  - Opportunities for innovation to reduce costs

## Break

# Session 7

- 9:45 – 10:15 **Session 7 – Presentation: State of EB Accelerator Technologies & Future Opportunities**
  - Charles Thangaraj Fermi /Gigi Ciovati Jefferson Lab/ Chase Boulware Niowave)
  - Existing industrial accelerators (IBA Rhodotron, Dynamatron, ILU, Mevex, etc)
  - New technology: Compact SRF accelerator concept
  - Development efforts in progress
  - New opportunities with compact industrial SRF-based accelerators
  - Economics of SRF E-beam treatment
  - Operations at Niowave

# Session 8

- 10:15-11:15 **Session 8 – Breakout into Moderated Groups**
- Where is E-Beam currently being used and where could it be used?
- What are the priority applications?
- What substances could be more easily addressed with EB: Today? In the future?
- Where does the power come from?

## Break

# Session 9

- 11:30 – 1:15 **Session 9 - Summary and Wrap-Up With Working Lunch (Dan Meeroff)**
- End

